

**VERTICAL MOSFETS HAVING TRENCH-BASED GATE ELECTRODES
WITHIN DEEPER TRENCH-BASED SOURCE ELECTRODES
AND METHODS OF FORMING SAME**

Abstract of the Disclosure

Methods of forming vertical MOSFETs include forming a base region of second conductivity type in a semiconductor substrate having a drift region of first conductivity type therein that forms a P-N junction with the base region. A source region of first conductivity type is formed in the base region and a deep trench, having a first sidewall that extends adjacent the base region, is formed in the substrate. The deep trench is lined with a first electrically insulating layer. The deep trench is then refilled with a trench-based source electrode. The trench-based source electrode is selectively etched to define a shallow trench therein and expose a first portion of the first electrically insulating layer that extends on the first sidewall of the deep trench. The first portion of the first electrically insulating layer is selectively etched to expose an upper portion of the first sidewall of the deep trench and reveal the base region. The shallow trench is lined with a gate insulating layer that extends on the exposed upper portion of the first sidewall of the deep trench and a bottom and sidewalls of the shallow trench. A gate electrode is formed in the lined shallow trench. A surface source electrode is also formed. This source electrode electrically connects the trench-based source electrode, source region and base region together.

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